Claims

What is claimed is:

1. An apparatus for retaining a plate wherein the plate may have any one of a plurality of different predetermined flange heights, the apparatus comprising:

a first positioning block comprising a retractably mounted first positioning arm, the first positioning block having a first plurality of retaining ledges; and

a second positioning block having a second plurality of retaining ledges , wherein at least one of the first plurality of retaining ledges is defined on the first positioning arm and the first and second positioning blocks are arranged to engagingly receive the plate and the first arm is adapted to selectively apply a first biasing force upon the plate to position the plate under at least one of the second plurality of retaining ledges.

2. An apparatus for positioning a plate in a predetermined plate alignment position, the apparatus comprising:

a plate loader adapted to translate along a translation path;

a first positioning block having a retractably mounted first positioning arm;

a second positioning block;

a plurality of plate positioning stops arranged in accordance with the predetermined plate alignment position;

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wherein the plate loader is adapted to loosely receive the plate and translate the plate between the first and second positioning blocks, the first and second positioning blocks being arranged to engagingly receive the plate, and

wherein the first positioning arm is adapted to selectively apply a first biasing force upon the plate to position the plate in the predetermined plate alignment position.

3. The apparatus of claim 2 wherein at least one of the plurality of positioning stops is a first positioning stop and is arranged on the plate loader to define the predetermined position of the plate along the direction perpendicular to the translation path.

4. The apparatus of claim 3 wherein the first biasing force pushes the plate against the first positioning stop.

5. The apparatus of claim 2 wherein at least one of the plurality of positioning stops is a second positioning stop and is arranged on the plate loader to define the predetermined position of the plate along the direction parallel to the translation path.

6. The apparatus of claim 5 wherein the first biasing force includes a frictional component force that pushes the plate against the second positioning stop.

7. The apparatus of claims 3 or 5, the plate loader having at least one horizontal surface for supporting the plate wherein the first positioning stop is a rim that at least partially defines a perimeter of the horizontal surface.

8. The apparatus of claims 3 or 5, the plate loader having at least one horizontal surface for supporting the plate wherein the first positioning stop comprises and arrestment surface arranged on a perimeter of the horizontal surface.

9. The apparatus of claim 2, the second positioning block further comprising a retractably mounted second positioning arm wherein the second positioning arm is adapted to apply a second biasing force to the plate that is lesser in magnitude than the first biasing force.

10. The apparatus of claim 1, the second positioning block further comprising a retractably mounted second positioning arm wherein at least one of the second plurality of retaining ledges is defined on the second positioning arm.

11. The apparatus of claim 10, the first positioning block further comprising a retractably mounted third positioning arm wherein at least one other of the first plurality of retaining ledges is defined on the third positioning arm.

12. The apparatus of claim 11 wherein at least one each of the first and second plurality of retaining ledges are first and second positioning block retainer ledges.

13. An apparatus for positioning and retaining a plate in a predetermined plate alignment position, wherein the plate may have any one of a plurality of different predetermined flange heights, the apparatus comprising:

a first positioning block comprising a retractably mounted first positioning arm, the first positioning block having a first plurality of retaining ledges, at least one of the first plurality of retaining ledges being defined on the first positioning arm;

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a second positioning block having a second plurality of retaining ledges;

a plate loader adapted to translate along a translation path and to loosely receive the plate, wherein the plate loader translates the plate between the first and second positioning blocks that are arranged to engagingly receive the plate; and

a plurality of plate positioning stops arranged in accordance with the predetermined plate alignment position,

wherein the first positioning arm is adapted to selectively apply a first biasing force upon the plate to position the plate in the predetermined plate alignment position under at least one of the second plurality of retaining ledges.

14. A device for detecting proper alignment of a plate, the device comprising:

a sensor housing having arranged therein:

a sensor;

a first retractable lever arm having first and second lever ends; and

at least one spring members arranged between a housing surface and the first lever arm so as to apply a biasing force on said lever arm,

wherein a properly positioned plate will contact each of the first and second lever ends and wherein the sensor is positioned in relation to the first lever arm so that each lever end must be displaced at least a predetermined distance by the plate in order to actuate the sensor.

15. The device of claim 14, wherein said at least one spring member comprises a first and second spring members arranged between the housing surface and

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the first lever arm so as to apply biasing forces at the first and second lever ends, respectively.

16. The device according to claim 14 wherein the first and second lever ends further comprise first and second lever projections.

17. The device according to claim 14 further comprising:

one or more first lever end stops arranged to restrict the displacement of the first lever end between a first lever end minimum and a first lever end maximum; and

one or more second lever end stop arranged to restrict the displacement of the second lever end between a second lever end minimum and a second lever end maximum.

18. The device according to claim 14, the sensor housing further comprising:

a second retractable lever arm having third and fourth lever ends;

third and fourth spring members arranged between the housing surface and the second lever arm so as to apply biasing forces at the third and fourth lever ends, respectively,

wherein the second retractable lever arm is positioned in relation to the first lever end of the first arm so that each of the third and fourth lever ends must be displaced at least a predetermined distance by the plate in order to displace the first lever end by at least the first predetermined distance.

19. An apparatus for training a probe to locate and aspirate reagents and/or one or more samples, the apparatus comprising:

a movable probe;

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a motion control system for moving the probe;

a fixed object having an alignment feature, the alignment feature comprising:

a first opening having a first opening area, the first opening being sized to receive the probe;

a second opening having a second opening area; and

a guiding surface having a guiding angle defined by the relative arrangement of said first and second openings to one another,

wherein said first opening area is greater than said second opening area and said first and second openings are concentrically arranged.

20. An apparatus for training a probe to locate and aspirate reagents and/or one or more samples, the apparatus comprising:

a movable probe;

a motion control system for controlling movement of the probe in at least a first direction along, and at least a second direction perpendicular to, the probe axis; and

a fixed object having an alignment feature, the alignment feature comprising:

a first opening sized in accordance with a fabrication tolerance of the apparatus; and

at least one guiding surface having at least one guiding angle,

wherein the motion control system is configured to (i) move the probe in the second direction to within an initial estimate of the alignment feature, (ii)

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release control of the probe so as to allow it to move freely in the second direction, and (iii) move the probe in the first direction into the alignment feature such that the at least one guiding surface guides the probe into precise alignment.

21. The apparatus according to claims 19 or 20 wherein the guiding surface is conical.

22. The apparatus according to claims 19 or 20 wherein the guiding surface is trapezoidal.

23. The apparatus according to claims 19 or 20 wherein the guiding surface is doubly curved.

24. The apparatus according to claim 20 wherein the alignment feature further comprises a second opening sized to closely receive the probe and arranged below the first opening, the first and second openings being connected by the guiding surface..

25. A method of training a probe to locate and aspirate reagents and/or one or more samples within a biological detection device, the method comprising the steps of:

a) moving the probe to an initial estimated position of an alignment feature, wherein the probe is moved in at least a first direction along, and at least a second direction perpendicular to, the probe axis, the alignment feature comprising:

a first opening sized in accordance with a fabrication tolerance of the device and at least one guiding surface having at least one guiding angle;

b) releasing control of the probe's motion in the second direction;

c) advancing the probe a predetermined distance in the first direction,

wherein the probe contacts the guiding surface and is guided in the second direction into an actual position of the alignment feature.

26. The method of claim 25 further comprising the steps of:

d) withdrawing the probe;

e) reactivating control of the probe's motion in the second direction;

f) homing the probe;

g) determining a calibration distance traveled in the second direction; and

h) determining an actual position of the alignment feature in accordance with the initial estimated position and the calibrated distance.

27. The method of claim 26 wherein the probe's motion is controlled by a computerized motion control system having a processor and a memory.

28. The method of claim 27 wherein a set of probe training instructions adapted to control the probe's motion is stored in the memory.

29. The method of claim 28 wherein the probe training instructions include one or more sets of refinement instructions adapted to cause the probe to perform one or more refinement measurements at one or more refinement positions.

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30. The method of claim 29 wherein the refinement instructions use the actual position of the alignment feature and the fabrication tolerance to determine the one or more refinement positions.

31. The method of claim 30 wherein steps a) through h) are repeated for each refinement position.

32. A fluid handling device for aspirating reagents, the device comprising:

a reagent manifold comprising:

an aspiration chamber having an access port, the aspiration chamber being defined within the reagent manifold;

a plurality of reagent input lines;

a gas input line arranged on the aspiration chamber above the plurality of reagent input lines;

a reagent manifold sealing surface,

wherein the reagent input and the gas input lines are in selective fluid communication with the aspiration chamber; and

a movable probe having a probe tip and a probe sealing surface,

wherein the probe sealing surface is adapted to sealingly engage the reagent manifold sealing surface when the probe is lowered into the aspiration chamber.

33. The device according to claim 32, wherein said plurality of reagent input lines are arranged at substantially the same height on the aspiration chamber.

34. The device according to claim 32 further comprising a seal configured to enclose the access port and to form a face seal when the probe is lowered into the aspiration chamber.

35. The device according to claim 34 wherein the seal is selected from the group consisting of an o-ring, a gasket, and an elastomeric material.

36. The device according to claim 35 wherein the seal is arranged on the probe sealing surface.

37. The device according to claim 35 wherein the seal is arranged on the reagent manifold sealing surface.

38. The device according to claim 36 wherein the probe sealing surface has a groove for mounting the seal.

39. The device according to claim 37 wherein the reagent manifold sealing surface has a groove for mounting the seal.

40. The device according to claim 32 further comprising a plurality of independently controlled valves for selectively placing each reagent line in fluid communication with the aspiration chamber.

41. The device according to claim 32 wherein the aspiration chamber and the probe each have a respective diameter, the aspiration chamber diameter being larger than the probe diameter.

42. The device according to claim 41 wherein the aspiration chamber diameter is 25% larger than the probe diameter.

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43. The device according to claim 32 wherein the aspiration chamber and the probe each have a respective height, the aspiration chamber height being substantially the same as the probe height.

44. An apparatus for detecting the presence/absence of a reagent having a reagent index of refraction, the apparatus comprising:

a fluid handling manifold having: (i) an exterior; (ii) a transparent light path defined therein; and (iii) a fluid conduit defined therein, wherein at least a portion of the fluid conduit comprises first and second planar fluid interface surfaces that intersect the light path;

a light source adapted to direct light into the light path; and

a light detector configured to detect light transmitted through the light path,

wherein the first and second fluid interface surfaces are arranged at fluid interface angles relative to the light path.

45. The apparatus of claim 44, the fluid handling manifold exterior having first and second planar exterior surfaces wherein the first and second exterior surfaces intersect the light path.

46. The apparatus of claim 45, wherein the first and second planar exterior surfaces are perpendicular to the light path.

47. The apparatus of claim 45 wherein the first and second exterior surfaces are substantially parallel.

48. The apparatus of claim 47 wherein the first and second exterior surfaces are arranged substantially perpendicular to the light path.

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49. The apparatus of claims 44-48 wherein the first and second fluid interfaces are substantially parallel.

50. The apparatus of claims 44-49 wherein the fluid handling manifold consists of a substantially transparent material having an index of refraction that is greater than the index of refraction of air.

51. The apparatus of claim 50 wherein the substantially transparent material has an index of refraction is greater than or equal to the reagent index of refraction.

52. The apparatus of claim 50 wherein the substantially transparent material has an index of refraction is greater than 1.4.

53. The apparatus of claim 50 wherein the substantially transparent material is selected from the group consisting of Lexan, acrylic, polycarbonate, Perspex, Lucite, Acrylite and polystyrene.

54. The apparatus of claims 44-53 wherein the light source is positioned to direct light at the first fluid interface surface at an angle of intersection greater than the critical reflectivity angle when air is present in the fluid conduit.

55. The apparatus of claims 44-54 wherein the angle of intersection of the light directed at the first interface surface results in less than about twenty percent (20 %) of the light being reflected at the first interface surface when the reagent is present in the fluid conduit.

56. The apparatus of claims 44-55 further comprising a control system adapted to send/receive control signals to/from the light detector and the light source.

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57. The apparatus of claim 56 wherein the control system is adapted to process the light generation signal and control an assay device.

58. A positive displacement pump comprising:

a pump chamber interface line from which the pump aspirates and dispenses fluid;

a first fluid line;

a second fluid line;

a 3-way valve having a first port, a second port and a common port, wherein the first port is linked to the first fluid line, the second port is linked to the second fluid line and the common port is linked to the pump interface line, the 3-way valve being operable to place either the first fluid line or the second fluid line in fluid communication with the pump interface line;

a bypass line having a bypass shut-off valve, the bypass line being linked to the first fluid line and the second fluid line,

wherein the bypass shut-off valve is operable to selectively link the first fluid line and the second fluid line.

59. The positive displacement pump of claim 58 wherein the bypass valve, when open, allows the first and second fluid lines to be flushed without operation of the pump.

60. The positive displacement pump of claim 58 wherein the first fluid line is an input line and the second fluid line is an output line.

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61. A positive displacement pump having a pump chamber, the pump chamber comprising:

a first opening adapted to receive a pump piston;

a second opening from which the pump aspirates and dispenses fluid;

a pump chamber cleanout opening,

a cleanout plug for sealingly engaging the pump chamber cleanout opening,

wherein removal of the cleanout plug allows the pump chamber to be flushed without operation of the pump.

62. The positive displacement pump of claim 61, wherein the second opening and the pump chamber cleanout opening are spaced substantially at opposite ends of the pump chamber.

63. The positive displacement pump of claim 61, wherein the pump cleanout opening provides a fluid path that is substantially tangent to the interior wall of the pump chamber.

64. The positive displacement pump of claim 61, the first opening further comprising a fluidic seal between the pump piston and the first opening.

65. The positive displacement pump of claim 61 further comprising a piston.

66. A positive displacement pump having a pump chamber, the pump chamber comprising:

a first opening adapted to receive a pump piston;

a gas trap;

a sediment trap;

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a first fluid line linked to the gas trap;

a second fluid line linked to the sediment trap;

wherein the first and second fluid lines are sized relative to one another such that (i) the fluidic resistance of gas through the first fluid line is less than the fluidic resistance of liquid through the second fluid line, and (ii) the fluidic resistance of liquid through the first fluid line is greater than or equal to the fluidic resistance of liquid through the second fluid line.

67. The positive displacement pump of claim 66, the first opening further comprising a fluidic seal between the pump piston and the first opening.

68. The positive displacement pump of claim 66, the gas trap is an angled groove along the top surface of the chamber and is arranged so that the first fluid line is linked to the topmost portion of the groove.

69. The positive displacement pump of claim 66, the sediment trap is an angled groove along the bottom surface of the chamber and is arranged so that the second fluid line is linked to the bottommost portion of the groove.

70. The positive displacement pump of claim 66, wherein the first and second fluid lines are directly connected to a single fluid interface line.

71. A method for retaining a plate wherein the plate may have any one of a plurality of different predetermined flange heights, the method comprising translating the plate so that it engages

a first positioning block comprising a retractably mounted first positioning arm, the first positioning block having a first plurality of retaining ledges; and

a second positioning block having a second plurality of retaining ledges , wherein at least one of the first plurality of retaining ledges is defined on the first positioning arm and the first and second positioning blocks are arranged to engagingly receive the plate and the first arm is adapted to selectively apply a first biasing force upon the plate to position the plate under at least one of the second plurality of retaining ledges.

72. A method for positioning a plate in a predetermined plate alignment position, the method comprising:

placing the plate in a plate loader adapted to translate along a translation path;

translating said plate loader along said translation path;

engaging the plate with a first positioning block having a retractably mounted first positioning arm;

engaging the plate with a second positioning block;

aligning the plate against a plurality of plate positioning stops arranged in accordance with the predetermined plate alignment position;

wherein the plate loader is adapted to loosely receive the plate and translate the plate between the first and second positioning blocks, the first and second positioning blocks being arranged to engagingly receive the plate, and

wherein the first positioning arm is adapted to selectively apply a first biasing force upon the plate to position the plate in the predetermined plate alignment position.

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73. The method of claim 72 wherein said plurality of positioning stops are arranged on the plate loader.

74. The method of claim 71, the second positioning block further comprising a retractably mounted second positioning arm wherein at least one of the second plurality of retaining ledges is defined on the second positioning arm.

75. The method of claim 74, the first positioning block further comprising a retractably mounted third positioning arm wherein at least one other of the first plurality of retaining ledges is defined on the third positioning arm.

76. A method for positioning and retaining a plate in a predetermined plate alignment position, wherein the plate may have any one of a plurality of different predetermined flange heights, the method comprising:

placing the plate on a plate loader adapted to translate along a translation path and to loosely receive the plate;

translating the plate loader along the translation path;

engaging the plate with a first positioning block comprising a retractably mounted first positioning arm, the first positioning block having a first plurality of retaining ledges, at least one of the first plurality of retaining ledges being defined on the first positioning arm;

engaging the plate with a second positioning block having a second plurality of retaining ledges;

wherein the first positioning arm is adapted to selectively apply a first biasing force upon the plate to position the plate in the predetermined plate

alignment position under at least one of the second plurality of retaining ledges.

77. A method for detecting proper alignment of a plate, the comprising contacting the plate with a plate alignment detector comprising:

a sensor housing having arranged therein:

a sensor;

a first retractable lever arm having first and second lever ends; and

first and second spring members arranged between a housing surface and the first lever arm so as to apply biasing forces at the first and second lever ends, respectively,

wherein a properly positioned plate will contact each of the first and second lever ends and wherein the sensor is positioned in relation to the first lever arm so that each lever end must be displaced at least a predetermined distance by the plate in order to actuate the sensor.

78. A method for introducing reagents into a fluidic probe, the method comprising:

moving a probe having a probe tip and a probe sealing surface into a reagent manifold comprising:

an aspiration chamber having an access port, the aspiration chamber being defined within the reagent manifold;

a plurality of reagent input lines arranged at substantially the same height;

a gas input line arranged above the plurality of reagent input lines;

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a reagent manifold sealing surface,

sealing the probe sealing surface against the reagent manifold sealing surface; and

aspirating gas or reagent from said gas input line or one of said plurality of reagent input lines.

79. The method according to claim 78 wherein said sealing is accomplished through a face seal.

80. The method according to claim 78 wherein the aspirating step comprises activation of a valve in said gas input line or said one of said plurality of reagent input lines.

81. A method for detecting the presence/absence of a reagent having a reagent index of refraction, the comprising:

shining a beam of light through transparent light path defined in a fluid handling manifold having: (i) an exterior; (ii) a fluid conduit defined therein, wherein at least a portion of the fluid conduit comprises first and second planar fluid interface surfaces that intersect the light path; and

detecting light transmitted through the fluid conduit

wherein the first and second fluid interface surfaces are arranged at fluid interface angles relative to the light path.

82. The method of claim 81 wherein said exterior of said fluid handling manifold has first and second exterior surfaces that intersect said light path, said first

and second exterior surfaces being substantially parallel to each other and perpendicular to the light path.

83. The method of claims 81-82 wherein the angle of intersection of the light directed at the first interface surface is between 45-60 degrees..

84. The apparatus of claims 81-83 further comprising determining if said fluid conduit is filled with said reagent.

85. A method of cleaning a fluidic system comprising a positive displacement pump, the fluidic system comprising a:

a pump chamber interface line from which the pump aspirates and dispenses fluid;

a first fluid line;

a second fluid line;

a 3-way valve having a first port, a second port and a common port, wherein the first port is linked to the first fluid line, the second port is linked to the second fluid line and the common port is linked to the pump interface line, the 3-way valve being operable to place either the first fluid line or the second fluid line in fluid communication with the pump interface line;

a bypass line having a bypass shut-off valve, the bypass line being linked to the first fluid line and the second fluid line,

the method comprising

opening the bypass shut-off valve to link the first fluid line and the second fluid line.

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flushing said first and second fluid lines.

86. A method for cleaning the pump chamber of a seized positive displacement pump having a pump chamber, the pump chamber comprising:

a first opening adapted to receive a pump piston;

a second opening from which the pump aspirates and dispenses fluid;

a pump chamber cleanout opening,

a cleanout plug for sealingly engaging the pump chamber cleanout opening,

the method comprising removing the cleanout plug and flushing the pump chamber.

87. A method for pumping a liquid that may contain air bubbles and/or particulate matter, the method comprising:

introducing the liquid into the pump chamber of a positive displacement pump, the pump chamber comprising

a first opening adapted to receive a pump piston,

a gas trap,

a sediment trap,

a first fluid line linked to the gas trap,

a second fluid line linked to the sediment trap,

and a single fluid interface line directly connected to said first and second fluid line;

operating the pump for a first period of time during which any air in said gas trap is displaced through said first fluid line; and

operating the pump for a second period of time during which any sediment in said sediment trap is displaced through said second fluid line.

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